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HARD- AND SOFTWARE PROBLEMS OF SPACED METEOR OBSERVATIONS BY OPTICAL ELECTRONICS

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An optical electronic facility is being used for meteor observations at the Turkmen Academy of Sciences Institute of Physical Technology along with meteor radars and astonomical TV.

The main parts of the facility are cameras using UM-92 optical electronic image tubes. The three-cascade optical electronic image-tube with magnetic focusing has a 40-mm cathode and resolution in the center of up to 30 pairs of lines/mm. The photocathode is of a multislit S-20 type.

For meteor spectra observations, replica gratings of 200 and 300 lines /mm are used as the dispersive element. The set of available camera lenses give stellar fields with angular dimension form 30° to 10° and stellar magnitude limits of 7^m-11^m. Depending on the combination of objective and replica used the spectrograms are recorded with inverse linear dispersions from 600 A/mm to 250 A/mm. In spectral observations, the limiting magnitude of the equipment for stars is 7^m-9^m and depends on the type of the input objective and replica.

A two-paddle shutter with a 1:2 ratio of closed and open segments gives 48 breaks a second.

The image recorder reproduces an image from the output screen of the image-tube on a photographic film on a scale of 1:1. The exposure time is chosen to be short enough to maintain dot-like stellar images as the cameras are mounted on nonguiding supports. The end of the exposure on each 18 x 24 mm frame is marked with readings of an electronic watch.

The spectral sensitivity of the cameras depends on spectral sensitivity of image-tube photocathode as well as optical parameters of the objective and replica. Fig. 1 shows the curve of the spectral camera sensitivity plotted on the basis of spectra for stars of different spectral class.

Fig. 2 gives the averaged field errors for various sections of the image-tube screen as obtained from photometric images of stars with different brightness.

To determine a stellar meteor magnitude from characteristic curves, a correction (Δm) as a function of the meteor image displacement along the cathode is used (Fig.3).

Fig. 4 gives experimental data on the image brightness decay of the output screen.

To carry out spaced meteor observations using the optical electronics equipment, we used stations spaced at 20.2 km, 12.8 km and 5.7 km distance

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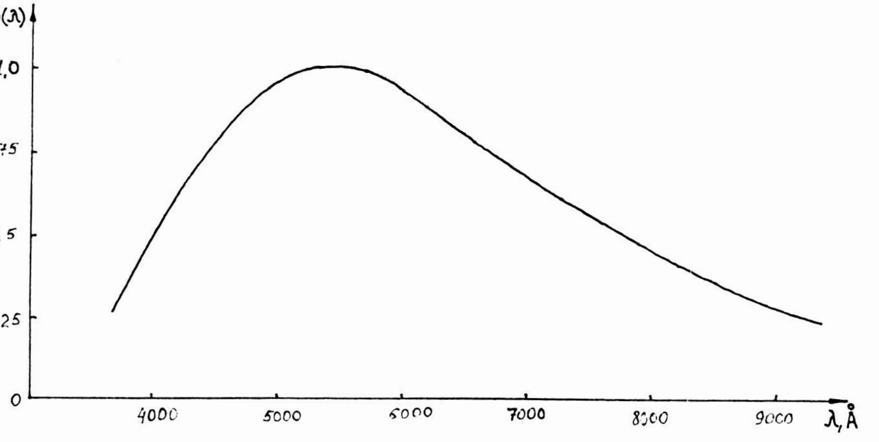

Fig. 1 Spectral sensitivity curve of the image-tube camera.

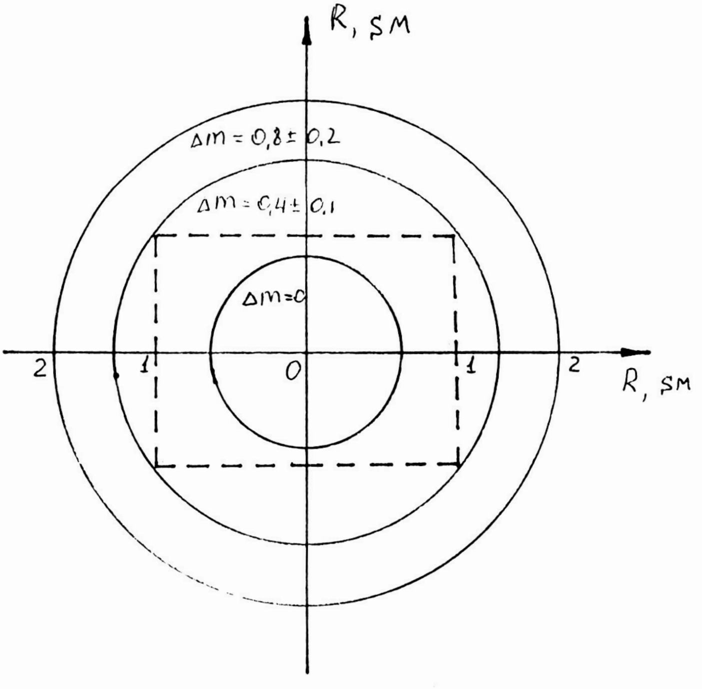

Fig. 2 Field error from the image-tube screen.

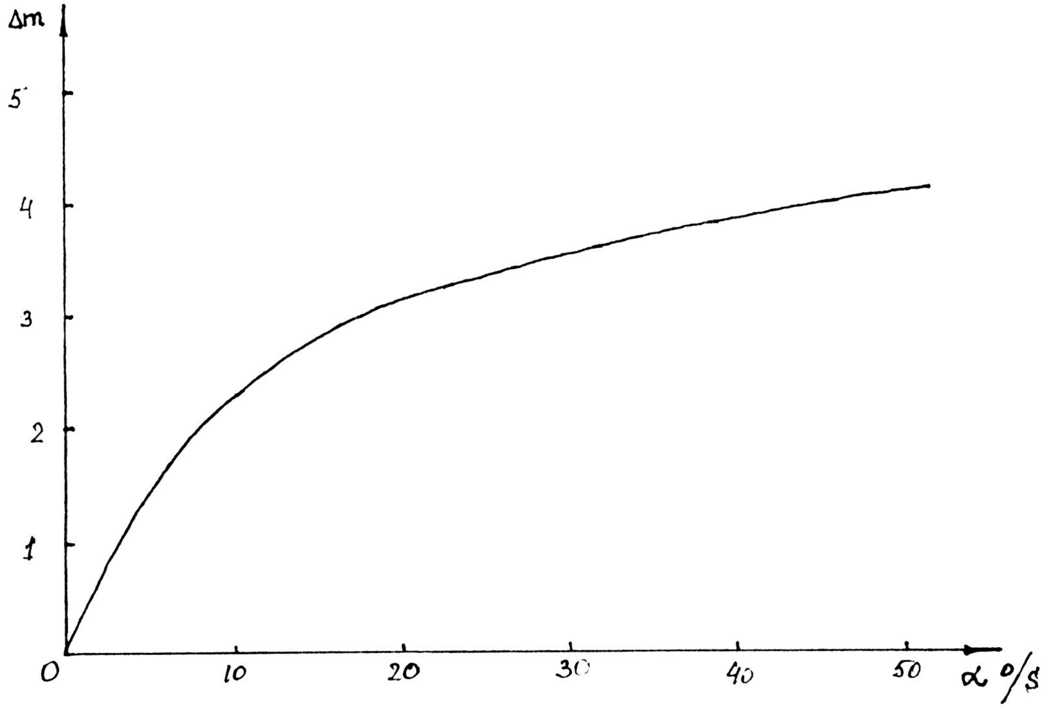

Fig. 3 Curve for determination of errors caused by meteor image displacement.

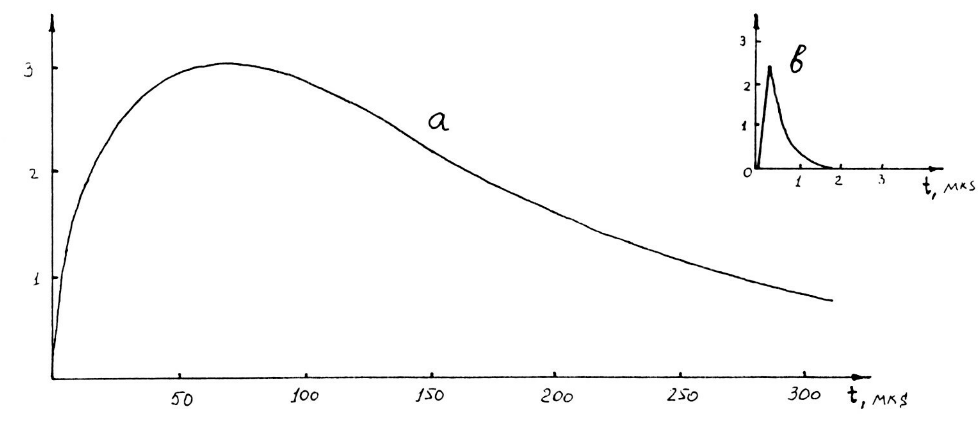

Fig. 4 Afterglow curve (a) observed on the image-tube output screen during photocathode lighting by light pulse of the form (b).

away from each other. Pairs of objectives for each base were selected so as to allow determination of characteristics of meteors from 0^m to $+9^m$ with about the same accuracy.

The center of the general viewing field was chosen along the line perpendicular to the base at 100 km.

The primary processing of basic meteor photographs involves:

1. identification and selection of standard stars;
2. measurement of standard stars and meteor points by measuring microscope;

3. photometric processing of negatives using a densitometer.

After identification of stars for each frame along the meteor path about 20 standard stars are chosen from both sides of the negative and some star closest to the geometrical center of the frame is chosen as the optical center of negative. Then the coordinates of the standard stars and optical center are taken from a catalogue.

Horizontal coordinates (X,Y) of standard stars, optical center and points on the meteor path are measured by a microscope. The frame is placed so that the direction of meteor movement coincides with that of one of the measuring microscope axes. Microscope setting of an investigated object is carried out three times and results for each measured point are averaged.

Photometeric processing is carried out by an automatic densitometer MD-100. If there are images in the frames following the initial appearance, the meteor trail image is recorded, then the zero-order trail is also photometered in order to determine its its decay. Then the meteor spectum is photometered along the dispersion direction for individual lines and bands.

Mathematical processing of spaced optical electronic observations of meteors was carried out on the Electronica-100/25 computer using the RAFOS operational system with FORTRAN.

The program structure and arrangement of basic data are conditioned by peculiarities of the observation method along with the technical parameters of the optical electronics equipment. As star images on the negatives show as dots, the meteor coordinates are determined directly in the system of coordinates α, δ.

All the initial information obtained after measurement of the negatives as well as data on equipment, observation sites and reduce values are registered in separate files.

For the case when a meteor image is recorded in a sequence of subsequent frames additional data is recorded in a subsidiary file.

Distortion is taken into account by means of stars of known coordinates that are used as reference points. Approximation and

interpolation can both be used for meteor coordinate point calculations. Approximation may seem preferable at first sight. However, actual calculations showed that approximation with 8th order orthogonal polynomials in both variables describes the relationships with less accuracy than interpolation between the closest reference points. It was found out experimentally that interpolation over four nearest reference stars serves our purpose the best.

Processing of spaced-meteor observational data is performed in several stages. Firstly, the equatorial meteor coordinates are determined for each negative. Calculated coordinates of meteor points α_i, δ_i, are smoothed out and reduced to a large circle. Then the radiant, heights and meteor particle velocity are calculated. And finally, the meteoroid orbital elements are determined.

An error of faint meteors parameters observed by the optical electronic technique shows that this method is not inferior in accuracy to the photographic one applied to observations of bright meteors.